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ABSTRACT

The purpose of this study is to provide day care center management and government funding agencies with empirical estimates of the costs of day care centers in Pennsylvania. Based on cost data obtained from the Department of Public Welfare and survey information from the Pennsylvania Day Care Study Project, average and marginal costs of day care services were estimated by employing the least-squares regression technique. The report is divided into five sections: (1) a literature review on four day care cost studies, (2) a description of the cost model used in this study, (3) data analysis (including summary tables), (4) a description of the estimation technique and presentation of the empirical results, and (5) a discussion of policy implications of the empirical cost relationships. Policy recommendations are made as well as suggestions concerning future research and data collection procedures. (Author/SDH)

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INSTITUTE FOR THE STUDY OF HUMAN DEVELOPMENT

CENTER FOR HUMAN SERVICES DEVELOPMENT

A COST ANALYSIS OF DAY CARE CENTERS IN PENNSYLVANIA

BY TEH-WEI HU AND KARL WISE

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Table of Contents

Page

Abstract....1

Introduction....1

Review of Literature on the Cost Analysis of Day Care Centers....3

The Model....11
- Type of Costs....11
- Output Measurement....11
- Specification of Cost Functions....12

The Data....19

Estimation and Results....27
- Method of Estimation....27
- Results....27

Conclusions, Policy Implications, and Future Research....40
- Conclusions and Policy Implications....40
- Future Data Collection and Research....42

Summary....45

References....47

Tables

Table 1 Statistical Summary of Coded Variables: Data Collected From Day Care Centers....20

Table 2 Statistical Properties of Variables: Data Collected From Day Care Centers....22

Table 3 Statistical Properties of Variables Used in the Regression Analysis: Data Collected From Day Care Centers....23

Table 4 Statistical Properties of the Total Cost Variables in the Regional Data....25

Table 5 Statistical Properties of the Average Cost Variables in the Regional Data....26

Table 6 Total and Average Cost Functions for Center Data with Enrollment as an Independent Variable....28

Table 7 Total and Average Cost Functions for Center Data with Enrollment and Teacher Salary as Independent Variables....34

Table 8 Marginal Costs of Enrollment for the Center Data.....35

Table 9 Total and Average Cost Functions for the Regional Data with Enrollment as an Independent Variable.....36

Table 10 Current Cost and Average Current Cost Functions for the Regional Data with Enrollment as an Independent Variable.....38

Table 11 Average and Marginal Costs of Day Care Centers.....39

Table 12 The Average Day Care Center Costs.....41

FIGURES

Figure 1 The Total Cost and Average Cost Curves for the Linear Total Cost Equation.....30

Figure 2 The Total Cost and Average Cost Curves for the Quadratic Total Cost Equation.....31

Figure 3 The Total Cost and Average Cost Curves for the Cubic Total Cost Equation.....32

A COST ANALYSIS OF DAY CARE CENTERS IN PENNSYLVANIA

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INTRODUCTION

The analysis of the costs of day care is useful because it can benefit two important groups. Inferences made from estimated cost functions would be very helpful to the management of day care centers on one hand and to government legislatures on the other. For instance, the optimal scale of the operation of a day care center and the extra cost of providing care for an additional child would be extremely useful to center management, while government legislatures could be informed of the magnitude of the costs involved in the day care centers they support. Since local, state, and federal governments are primary sources of funds for day care centers, legislatures should know such information as the total operating cost of a center, the average cost, and the marginal costs of providing care in day care centers of various sizes of enrollment. It is with these two groups in mind, management and government, that this cost analysis was undertaken.

The cost analysis of day care presented here is divided into five sections. First the literature on four day care cost studies is reviewed so that the reader will have knowledge of the different types of cost analyses that have been performed and the conclusions that have been drawn about the costs of day care. Then the cost model used in this study is introduced. Included in this section are the specification of the cost

functions, an explanation of the output measurement, and a discussion of other variables used as independent elements in the cost equations. An examination of the data follows. Summary tables of the statistical properties of all the variables included in the data base are presented. In the fourth section the estimation technique is explained and the empirical results are presented and examined. The fifth and last section discusses the policy implications of the empirical cost relationships in reference to the more efficient management of day care centers and the usefulness of these relationships in allocating resources among day care centers. Also, suggestions for future data collection and suggestions for further research are made in this last section.

Review of Literature on the Cost Analysis of Day Care Centers

Four major cost studies of day care centers have been made since 1968. The first study, entitled *Standards and Costs for Day Care*, was conducted by the Children's Bureau of the U. S. Department of Health, Education and Welfare and the Day Care and Child Development Council of America (CB-DCCDC) (Sugarman, 1968). The CB-DCCDC investigation showed that the estimated annual national cost per child for "desirable" care is $2,320 (Sugarman, 1968, Table I). The second study of day care costs was conducted by Abt Associates, Inc. (1971). The Abt study estimated a functional budget for a model day care center of 25 children and found the cost per child to be $2,349 (1971, Vol. III, Table I, p. 53). The third cost analysis was conducted by the Westinghouse Learning Corporation and Westat Research, Inc. (1971). This study's figures showed "custodial" care to cost $324 per child annually and "developmental" care to cost $1,368 per child annually (Rowe, 1971, p. 255). Finally, Eva C. Galambos of the Southeastern Day Care Project wrote *A Cost Analysis System for Day Care Programs* (1971). She calculated day care center costs per child-day enrolled to be $12.43 (1971, Exhibit VI). If this figure is projected for a 250 day year, her calculated annual cost per child would be about $3,100.

Clearly, all the figures for the four separate studies are not in complete agreement as to just what the costs of child care actually are. In *The Economics of Child Care* Mary P. Rowe, an economic consultant, analyzed the first three studies mentioned (1971, pp. 272-313). She found three major reasons why their cost figures varied. Data questions, pricing questions, and cost-quality questions were what caused the major differences.

When handling data, it is almost impossible to compare any two values unless the units of measurement are the same. In applying this thought to day care program costs, one must be sure that the costs being measured are in the same standard form. A standard form of measurement can be defined in many ways, but Rowe suggested that the easiest form to use for day care centers is a 10-hour-a-day program for 250 days a year (1971, p. 273). If the purpose of the study is to estimate cost per child-hour one must specify whether cost is "per child enrolled" or "per child attended." Since the standard center is open about 10 hours a day and the average child is in attendance only 8.5 hours a day, Rowe related that costs of child care actually delivered per child-hour are probably about 15% higher than if the centers were filled throughout the whole day (1971, p. 274).

If costs are to be estimated on the basis of cost per year, then one must differentiate between costs based on average daily attendance and costs based on days of enrollment. The Abt study gave cost on the basis of average daily attendance; this method conforms with Rowe's standard for costs per child-hour delivered. All other studies gave costs on the basis of enrollment. In the Abt study the average daily attendance was 12% lower than the enrollment (Rowe, 1971, p. 274). Such a difference between enrollment and attendance is large enough to make knowledge of the unit of measurement mandatory when one is comparing two programs.

Another data question must be answered with respect to the imputed costs of donated goods and services. From center to center, the percentage of program costs which are "in-kind" vary from 5 to 70% in the Abt study. A realistic comparison of costs between centers, and between cost studies, cannot be made unless all costs are included, donated items being no exception.

A final problem to be overcome in the standardization of the data is the differentiation between budgets which include "set-up" costs and those which only include recurrent costs. Set-up costs generally include licensing, the initial training of staff, payment for utilities and space before the program opens, etc. Recurring costs are those which are paid yearly, or on a regular basis; such costs include the amortization of buildings and equipment. When comparing budgets, it is important to know if the "out-of-pocket" expenditure for equipment is included or if the equipment has been depreciated and the allowance taken into account in the budget.

Upon careful analysis of each of the budgets, one can readily see that data differences account for many of the differences in the child care costs of the four studies. Rowe stated, "Data differences alone easily account for the reported differences in costs between the 'developmental' centers of the Westat Survey (average cost $1,368) and the centers and systems of the Abt study (average cost about $2,300 [1971, p. 276]."

There are several reasons why the Westat survey figure was so much less than the Abt study figure. First of all, the Westat survey did not account very well for in-kind resources, due to poor interviews. Secondly, the Westat survey calculated full-time equivalent children on a basis of a 7-hour day, rather than on the standard of an 8.5-hour day. Also, two children who were part-time were considered equal to one full-time child even though the typical part-time child is at a center for only 2.5 to 3 hours a day. Therefore, when compared to the standard presented by Rowe, the number of children was overestimated and the costs were underestimated. Also, it seems that the Westat survey did not specify the number of days per year which was used as a standard. The Abt study had

a range of 225 to 253 days over the sample of centers. The variance in the range of days in the Abt study should point out the difference in costs that could result from different standards.

The CB-DCCDC study is probably the best when the four studies are judged on the basis of their use of a standard form of accountability. It conformed to the standard 10-hour a day program and the 250-day year.

The second reason for the differences between the cost figures of each study was pricing. Questions must be raised as to the price adjustments made for regional differences and inflation. Some federal agencies have reported a range of $1,000 to $1,900 for the same type of program in various parts of the country (Sugarman, 1968, p. 1). These variations reflect salary differences and cost of living differences, which must be taken into account when making any type of cost analysis. The CB-DCCDC investigation was done in 1963, while the Abt study, the Galambos study, and the Westat survey refer mostly to 1970 data. The fact that the studies were made in different years and locations may account for some of the difference in the figures.

The third and final reason which Rowe related as the cause of the differences in the figures was that of cost-quality. When all the data has been standardized and adjusted for regional price variation, any remaining differences in costs should be due to differences in the quality of the program offered by the day care centers. All of the studies, except the Galambos one, took quality differences into account, even though various units of measurement were used. The CB-DCCDC rated quality as minimum, acceptable, and desirable (Sugarman, 1968, p. 1). This breakdown was based on the degree that program activities focused on the

developmental needs of the children. Rowe stated that careful analysis of the three quality levels showed that the cost of care at each level varied with the staff/child ratio in that nearly all of the increase in cost from minimum quality care to desirable quality care could be attributed to more staff time per child (1971, p. 281).

The Abt study did not define quality as rigorously as the CB-DCCDC study. Instead, a team of experts from several different government and nonprofit organizations nominated 132 "quality" day care centers (1971, Vol. II, p. 6). Twenty centers were selected as the final "high quality" centers to be used in the study. The Abt study reported, "Final selection was based on overall project quality, presence and variety of quality program elements, and coverage of 'special case' situations [1971, Vol. II, p. 6]."

The Westat survey made an attempt to describe what actually existed in the form of full-time day care by surveying 289 day care centers. The study distinguished three different types of day care: Type A, or "custodial," offered the basic elements of food, shelter, and adult supervision; Type B, or "educational," offered the same as A, but it also included some form of an educational program; Type C, or "developmental," offered the same elements as A and B, but it also included some activities directed at the social well-being of the children and parents, such as health care, parent participation, counseling, or creative activities (Westinghouse Learning Corporation and Westat Research, 1971, p. 8). Each center in the survey was classified as A, B, or C. The facility, staff, equipment, and program were used as the basis for the determination. Rowe stated that these three classifications were based on the program goals of the center and not on the relative success at achieving the goals.

One can compare the annual cost per child for "desirable" care in the CB-DCCDC study and the annual cost per child in the Abt study budget and see that the two figures are almost identical. Before drawing any conclusions, however, one must realize that the costs in the Abt budget were calculated on the basis of average daily attendance rather than on enrollment, as in the CB-DCCDC budget. If the Abt study figure is calculated on an enrollment basis, the cost would become $2,067, and this figure widens the gap between the Abt cost figure and the "desirable" care cost figure in the CB-DCCDC study. Also, since CB-DCCDC data was taken from the late 1960's and the Abt data from 1971, the CB-DCCDC figures must be inflated in order to compare the two studies accurately. This inflation would raise the CB-DCCDC cost per child for the "desirable" program from $2,320 to about $2,500 to $2,600 (Rowe, 1971, p. 285).

The higher cost of the CB-DCCDC study's "desirable" care was largely due to transportation expenditures and the salaries of a social worker and specialized classroom personnel (Rowe, 1971, p. 285). Another reason for the cost difference was the more favorable CB-DCCDC staff/child ratio. If the functional budgets of the Abt study and the CB-DCCDC study are compared, the cost of standard staff functions is the same (Rowe, 1971, p. 286). Therefore, one can conclude that the two budgets were fundamentally the same, and it was only in areas of specialized personnel that the real differences in cost occurred.

In an attempt to compare the Westat study to the CB-DCCDC study and the Abt study, Rowe stated that no functional budget or staff/child analysis could be made because there were several data limitations in the Westat study, limitations such as brief cost interviews, the probable

underestimation of in-kind resources, the irregular inclusion of the costs of management and staff, and the different method of accounting for children who attended the centers an equivalent of full-time (Rowe, 1971, p. 290).

When the data limitations of the Westat study are ignored, the staff/child ratio becomes the primary difference between the three types of centers defined in the survey. If one expands the educational opportunities and program scope, then obviously more personnel and time are needed. This kind of change can be reflected in an increased staff/child ratio, which, Rowe stated, is "by far the most powerful influence on both costs and 'quality,' as operationally defined in the studies cited, and is mainly responsible for the designations 'desirable' and "developmental' [1971, p. 294]." Discounting the idea that the nominal differences in the cost figures for each of the studies is due more to the cost of the increased "program scope" of activities, Rowe related that the most important difference was the variation in the staff/child ratio.

A brief look at the Southeastern Day Care Project reveals that Eva Galambos made no analysis of the different qualities of child care. The data was standardized for a full fiscal year, and other adjustments were made for purposes of comparisons between centers in the sample. A functional budgeting method was generally defined and applied to the analysis (1971, pp. 3-5). All resources were accounted for in the study, including depreciation allowances and the prices of all donated goods and services. If the figure Galambos derived for cost per child-day enrolled, $12.43, is multiplied by 250 days per year, then the annual average cost per child enrolled would be about $3,100. This figure is greater than the inflation-adjusted "desirable" quality care figure in the CB-DCCDC budget, but it is still in line with Rowe's cost analysis of the other three studies.

One can see that there exist many questions that must be answered with respect to the data, prices of resources, and differences in quality before any comparison can be made of the four cost analyses. Once the data has been standardized for the different studies and the prices have been adjusted for regional differences and inflation, most of the remaining differences in cost between different day care center programs can be attributed to the increase in the staff/child ratio, or to the degree of educational and child-developmental activities. Rowe concluded that in order for a center to meet Federal interagency salary requirements, provide a homelike environment, and meet the CB-DCCDC's standard of "desirable" quality care, its budget must reflect program costs of at least $2,000 per child-year (Rowe, 1971, p. 294).

The Model

Types of Costs

Day care costs can be broadly classified into two groups: current costs, which include expenditures for such items as teacher salaries, equipment maintenance and repair, administrative costs, and other instructional costs, and capital costs, which include the costs of buildings and equipment.

In this study the costs of day care were analyzed with four statistical functions: a total cost function, an average total cost function, a total current cost function, and an average current cost function. The total cost functions permit inferences about the marginal cost, or the extra cost, of providing care for one more additional child in a day care center. Marginal costs are derived by computing the change in total costs divided by a change in the number of enrollment. The average cost function permits inferences about the optimal scale of operation for a day care center. That is, it allows inference about the enrollment level that will permit operation at the minimum cost per child. Average costs are derived by dividing the total costs by the level of enrollment.

Output Measurement

The output variable in this model is enrollment, that is, the total number of children enrolled in the day care center. The basis for this output measurement is the assumption that each child receives a given proportion of the total care and education given by the day care center in one year. The total volume of output of the day care service can be approximated, therefore, by the number of children enrolled in the center.

As was mentioned in the review of literature, a distinction must be made between costs based on enrollment and costs based on average daily attendance. Costs based on average daily attendance offer a more accurate picture of the per unit costs of day care than costs based on enrollment. In this study, however, no data on the average daily attendance were available; therefore, enrollment had to be used as the output measurement.

Specification of Cost Functions

A cost function is the relationship between cost and its output. In this study, the cost function was specified as: cost as a function of enrollment. Seven different cost functions were explicitly specified, all of which were different forms of the cost-enrollment relationship. The four equations listed below are the alternative total cost equations used in this study.

1. $TC = a + bTE + u_1$
2. $TC = a + bTE + cTE^2 + u_2$
3. $TC = a + bTE = cTE^2 + dTE^3 + u_3$
4. $\text{Log } TC = \text{Log } a + b\text{Log } TE + u_4$

The variables used are defined as follows:

TC = total cost is total current operating expenditures in dollars for day care centers in Pennsylvania, fiscal year 1971-72.

TE = total number of children enrolled in day care centers in Pennsylvania, fiscal year 1971-72.

u_1, u_2, u_3, u_4 = error term

Equation 1 is the linear formulation of the general cost equation. It says that for any change in enrollment, total cost will change by a constant

amount relative to the change in enrollment. As stated earlier, the marginal cost of a change in enrollment is the extra cost of taking care of one more additional child. Therefore, if enrollment changes by one unit, then total cost will change by a constant relative to that change in enrollment. The constant by which total cost changes is mathematically determined by the first derivative. The result is the coefficient of the output measurement. In summarizing, the linear total cost function specified in Equation 1 is useful for making inferences about the marginal cost of taking care of an additional child. If one more child is provided care, then total cost will change by the value of the coefficient of enrollment.

Equations 2 and 3 are respectively the quadratic and cubic forms of Equation 1. One can note that one of the independent variables in Equation 2 is a squared term and one of the independent variables in Equation 3 is a cubic term. The marginal cost of taking care of an additional child in the quadratic and cubic forms is found by using the same method of differential calculus as above. In order to determine the marginal cost, once the first derivative is found, average enrollment may be substituted into the differential equation, the implication being that marginal cost in the quadratic and cubic formulations is dependent upon the level of enrollment.

Equation 4 is the logarithmic formulation of the linear cost relationship. The equation in logarithmic form is very useful for making inferences about elasticity. Elasticity refers to the percentage change in the total cost of day care operations in a center with respect to the percentage change in the number of children enrolled. The elasticity is the coefficient of the logarithmic term in the equation. By definition,

the derivative of the logarithmic cost equation is the elasticity coefficient "b". If the elasticity is greater than unity, then a percentage change in total cost will be greater than the percentage change in enrollment. If b is less than unity, then a change in enrollment results in a smaller percentage change in total cost. If b equals unity, then the percentage change in total cost will be exactly the same as the percentage change in enrollment.

The average cost function permits inference about the optimal scale of operation for a day care center. Three alternative average cost functions were used in this study; they are formulated as follows:

5. $AC = a/TE + b + u_5$

6. $AC = a/TE + b + cTE + u_6$

7. $AC = a/TE + b + cTE + dTE^2 + u_7$

The variables used are defined as follows:

AC = average current operating expenditures per enrolled child in dollars for day care centers in Pennsylvania, fiscal year 1971-72.

TE = total number of children enrolled in day care centers in Pennsylvania, fiscal year 1971-72.

u_5, u_6, u_7 = error term

Average cost equations 5, 6, and 7 are derived from the total cost equations 1, 2, and 3, respectively, by dividing each total cost equation by the variable TE.

Employing the principle of diminishing marginal returns, economists usually expect to find "economies of scale" and "diseconomies of scale." Average cost is usually considered higher for a small unit of output due to initial set-up costs. As the unit of output increases, the average

cost decreases. However, a point is reached in the growth of the scale operation where average costs begin to rise. Graphically, this path of the average cost curve is traditionally considered U-shaped. The part of the curve where average cost is decreasing is where economies of scale are said to exist. The part of the curve where average cost is increasing is where diseconomies of scale are said to exist.

The discussion of elasticity earlier in this section corresponds to this analysis. When b is less than unity, the percentage change in total cost resulting from a percentage change in enrollment is less than the percentage change in enrollment. When elasticity is less than one, there exist increasing returns to scale or economies of scale. When the elasticity is greater than one, there exist decreasing returns to scale or diseconomies of scale. When the elasticity equals one, there exist constant returns to scale.

The reasons usually given for the existence of economies of scale include two broad forces: the specialization and division of labor and technological factors (Ferguson, 1969). These two factors enable the producer to reduce average cost by expanding the scale of operation. Diseconomies of scale, on the other hand, are said to exist when the scale of operation expands beyond a certain point and managerial limitations occur which hinder efficient production (Ferguson, 1969). Due to the relative strength of the economies and diseconomies of scale, one really does not know where the former ends and the latter begins. However, empirical evidence has shown that the average cost curve decreases up to a certain scale of operation. Beyond this point, it becomes increasingly difficult to prove specifically that average cost is increasing or whether it is relatively constant.

The usefulness of the average cost function is apparent if one relates the preceding theoretical analysis to this model. If lower per unit costs are obtained when enrollment increases, economies of scale would exist. If the average cost function is U-shaped, a point would be reached past which any further expansion in enrollment would increase average cost. This point is the minimum point of the average cost curve. The average cost function in this model permits inference about the enrollment level that will allow the operation of a day care center at the minimum cost per enrolled child.

In order for this average cost curve to reach a minimum point and then rise as enrollment increases, it is necessary to use a nonlinear average cost equation. The derivation of the average cost relationship from the quadratic total cost equation (Equation 2) and the cubic total cost equation (Equation 3) is thus needed. Therefore, for purposes of empirical consistency, three average cost formulations were included in this study.

Costs of day care are influenced by factors other than enrollment, such as the quality of the center and the location of the center. Measurement of quality is possible using a ratio of children to teachers, that is, assuming that the quality of day care is actually a function of the child/teacher ratio. The basis for this assumption is empirical research which has found that the smaller the ratio, i.e., the less children per teacher, the better the quality of care provided the child (Rowe, 1971). Since in this study no data was collected on the number of teachers, a child/teacher ratio was not possible.

An alternate measure of quality could be the educational level of the teacher. This measure is based on the assumption that the higher

the level of education, the better the care and quality of instruction. Again, since no information was available on the educational level of the teachers, it was not possible to use this measure either. However, it was possible to use the average salary of the teachers as an alternate representation of the educational level and, therefore, as a proxy for the quality of day care.

A separate cost model was used in this study with average teacher salary as an independent variable in each equation. This alternate cost model is as follows:

1a. $TC = a + bTE + cTS + u_1$

2a. $TC = a + bTE + cTE^2 + dTS + u_2$

3a. $TC = a + bTE + cTE^2 + dTE^3 + eTS + u_3$

4a. $\text{Log } TC = \text{Log } a + b\text{Log } TE + c\text{Log } TS + u_4$

5a. $AC = a/TE + b + cTS + u_5$

6a. $AC = a/TE + b + cTE + dTS + u_6$

7a. $AC = a/TE + b + cTE + dTE^2 + eTS + u_7$

This model is exactly the same as the original model presented except for the new independent variable, average teacher salary. All the variables are defined exactly as before, and average teacher salary is defined as follows:

TS = average salary, in dollars, of teachers in day care centers in Pennsylvania, fiscal year 1971-72.

The empirical results of this model are examined separately in a later section of this report.

Another factor that possibly influences the cost of day care is the location of the day care center. It would be valuable to use a dummy

variable in each regression equation, in which 1 would equal urban and 0 would equal rural for each observation, and then check for the significance. In this study, however, it was impossible to include location as a variable due to the fact that the regression sample of observations consisted almost completely of urban day care centers. Therefore, the significance of location cannot be determined until a more representative sample of the day care centers in the state is available.

The Data

Data were collected from two sources: The Pennsylvania Day Care Study Project at The Pennsylvania State University, which conducted interviews of 243 centers in Pennsylvania, and the Department of Public Welfare, which maintains a file of monthly invoices of costs incurred by about 35 regional day care systems. The center data consisted only of total operating costs, or current costs, while the regional data consisted of total costs, including both capital and current costs. Current costs from the regional data were obtained by subtracting the contractual costs of space and equipment from the total cost.

The usable sample size for the center data from the Pennsylvania Day Care Study Project, after all nonrespondents for each variable were excluded, was 62 centers. The usable size for the regional data from the Department of Public Welfare was 21 systems.

The current cost variable from the day care center data was actually the total operating expenditures in dollars for either one fiscal year, 1971-72, or one calendar year, 1971. The total enrollment for each center was an aggregation of the enrollment in each of the four following age groups: less than 3 years, 3 to 4 years, 5 to 6 years, and over 6 years of age.

Statistical summaries of day care center data are presented in Tables 1-3, while Table 4 and Table 5 contain data concerning the regional systems. Table 1 shows the percentage distribution of the basic variables; the observations were coded in the form used for dummy variables. Table 2 consists of the variables, other than the dummy variables, that were in the data base but were not used in the regression analysis. Table 3 shows the

TABLE 1

STATISTICAL SUMMARY OF CODED VARIABLES

DATA COLLECTED FROM DAY CARE CENTERS

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Variable	Number of observations	Code	Percentage distribution (based on a population of 243 obs.)
License from Department of Public Instruction	221	1 = no 2 = yes	34% said yes
Time period for one year	222	1 = fiscal 2 = calendar 3 = other 4 = don't know	27% said fiscal 14% said calendar
Source of funds:		1 = directly received from 2 = known to receive from 3 = believed to originate from 4 = more than one of above	
Social Security Act, Title IV-A	115		42% said directly received from or known to receive from
Economic Opportunity Act	27		9% "
Manpower Development and Training Act	6		2% "
Elementary and Secondary Education Act	33		12% "
Model Cities Program	19		7% "
Other federal funds	52		19% "

(Continued)

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TABLE 1 (Con't.)

Statistical Summary of Coded Variables

DATA COLLECTED FROM DAY CARE CENTERS

Variable	Number of observations	Code	Percentage distribution (based on a population of 243 obs.)
State funds	85		29% said directly received from or known to receive from
County funds	82		33% "
Municipal funds	12		5% "
School board	24		9% "
Other public funds	18		7% "
Parent fees only	45		18% "
Parent fees plus other sources	33		14% "
Business or industry payments and/or contributions	15		6% "
Labor union payments and/or contributions	2		1% "
United Fund grants	59		21% "
Contributions either personal or foundation	54		19% "
Other private funds	48		17% "

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TABLE 2

STATISTICAL PROPERTIES OF VARIABLES

DATA COLLECTED FROM DAY CARE CENTERS

Variable	Number of observations	Total	Mean	Standard error of mean
Average salary of paid teaching staff: (in dollars)				
Director	143	1,289,595	9,018.15	294.88
Assistant director	38	297,656	7,833.05	546.93
Head teacher	135	932,045	6,904.04	330.75
Teacher aide	190	713,710	3,756.37	98.32
Average age of paid teaching staff: (in years)				
Director	145	5,819	40.13	0.93
Assistant director	33	1,191	36.09	1.96
Head teacher	115	3,946	34.31	1.06
Teacher aide	157	5,447	34.69	0.84
Total number of children enrolled:				
Less than 3 years old	31	1,291	41.65	29.01
3 to 4 years old	215	3,610	16.79	1.17
5 to 6 years old	203	3,020	14.88	4.01
Over 6 years old	80	910	11.37	1.99

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TABLE 3

STATISTICAL PROPERTIES OF VARIABLES USED IN THE REGRESSION ANALYSIS

DATA COLLECTED FROM DAY CARE CENTERS

Variable	Number of observations	Total	Mean	Standard error of mean
Total operating expenditures (in dollars)	174	12,903,555.00	74,158.36	7,162.97
Total enrollment	62	2,532.00	40.84	5.24
Average operating expenditures (in dollars)	62	155,347.41	2,505.60	374.88
Average salary of teachers (in dollars)	154	916,482.00	5,951.18	159.85

statistical properties of the variables used in the total and average current cost functions. Table 4 presents the statistical properties of the total cost variables from the regional data. And Table 5 lists the statistical properties of the average cost variables from the regional data.

Much useful information can be gained from Tables 1-3. About 42% of the centers in the survey received funds from the Social Security Act, Title IV-A, and about 30% of the centers received funds from the state or the county. Only 34% of the surveyed centers received a license from the Department of Public Instruction. The average operational expenditures for a day care center with an average enrollment of 40 children was about $74,000. Thus, the average operating expenditure per child was about $2,500. The average teacher salary was about $5,900.

Regional data (Tables 4 and 5) show a more detailed classification of the types of expenditures. Obviously, personnel costs were the major item; they accounted for about 62% of the total cost or for 68% of the total operating cost. The second major item in the total cost was the expenses of consultant and contract services. Although the total current cost per day care center from the regional data (about $69,000) was smaller than that of the survey data ($74,000), the average current cost per child ($3,280) in the regional data was about $780 more than the average cost per child in the survey data. The average total cost (including capital cost) in the regional data was $3,580. Therefore, capital and equipment costs contributed about $300 per child per year to the day care centers in the regional systems.

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TABLE 4

STATISTICAL PROPERTIES OF THE TOTAL COST VARIABLES IN THE REGIONAL DATA

Variable	Number of observations	Total	Mean	Standard error of mean
Number of centers	22	164.00	7.45	1.68
Number of children enrolled	22	5,358.00	243.54	110.21
Personnel	22	8,730,535.00	396,842.50	205,576.47
Consultant and contract service	22	2,079,747.00	94,533.95	30,180.23
Travel	22	442,866.00	20,130.27	8,151.90
Consumable supplies	21	750,864.00	35,755.41	20,611.47
Equipment and furniture	22	477,448.00	21,702.18	12,626.52
Space	21	797,760.00	37,988.57	16,688.57
Other costs	22	755,064.00	34,321.09	17,427.65
Total costs	22	14,004,933.00	636,587.86	284,373.72
Current cost (Total cost minus cost of equipment and space)	21	12,290,853.00	585,278.71	268,557.45

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TABLE 5

STATISTICAL PROPERTIES OF THE AVERAGE COST VARIABLES IN THE REGIONAL DATA

Variable	Number of observations	Total (per center)	Mean (per enrollment)	Standard error of mean
Average cost of personnel	21	44,370.36	2,112.87	457.91
Average cost of consultant and contract service	21	13,681.35	651.49	321.99
Average cost of travel	21	4,871.05	231.95	109.95
Average cost of consumable supplies	21	2,812.41	133.92	21.63
Average cost of equipment and furniture	21	2,150.83	102.42	36.12
Average cost of space	21	4,079.62	194.27	43.41
Average of other costs	21	3,374.70	160.70	50.95
Average total cost	21	75,193.95	3,580.66	1,011.13
Average current cost	21	68,963.50	3,283.98	936.82

Estimation and Results

Method of Estimation

The estimation method used to determine the cost functions was the least squares regression technique. The purpose was to estimate the regression coefficients subject to the condition that the coefficients provide the best fit of the regression line based on the observed data. In other words, the technique minimizes the sum of the squares of the errors. In the analysis errors are determined by the differences between the estimated and actual values of the dependent variables. The advantage of using the regression technique is that it enables one to test certain hypotheses, measure the magnitude of the effect of certain independent variables, and make predictions concerning the dependent variable. In making statistical inferences about the regression coefficients, one assumes that the error terms are normally distributed with a zero mean and a constant variance.

Results

The cross-section of data described in the previous section were used to estimate statistical cost functions. Table 6 shows the total current cost equations and the average current cost equations from the center data when enrollment was used as an independent variable. As has been indicated earlier, the total cost function permits inference about the marginal cost of taking care of an additional child, and the average cost function permits inference about the optimal scale of operation of a day care center. In this study, there was one linear total current cost function and two nonlinear total current cost functions with two sets of data. The marginal cost in the linear case of the center data was simply the coefficient

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TABLE 6

Total and Average Cost Functions for Center Data With Enrollment as an Independent Variable

Equation	Constant	TE	$(TE)^2$	$(TE)^3$	Log TE	$(TE)^{-1}$	$\bar{R}^2$	F
1 (TC)	20768.83 (19477.88)	1537.69[b] (336.94)					0.25	20.83
2 (TC)	-10074.82 (29328.04)	2899.72[b] (1029.96)	-7.42 (5.30)				0.26	11.56
3 (TC)	98599.76[b] (35138.81)	-4392.20[a] (1853.89)	94.23[b] (23.10)	-0.34[b] (0.08)			0.44	16.93
4 (LOG TC)	3.79[b] (0.26)				0.58[b] (0.17)		0.15	11.53
5 (AC)	1611.47[b] (635.02)					19863.99[a] (11482.68)	0.03	2.99
6 (AC)	1775.77 (1115.43)	-2.12 (11.80)				18139.91 (15029.49)	0.02	1.49
7 (AC)	2435.23 (2122.81)	-18.41 (46.05)	0.07 (0.20)			12771.57 (21075.89)	0.00	1.02

Notes.--N = 62; standard errors are in parentheses; all figures are in dollars; the F value was used to test the significance of the whole equation; $\bar{R}^2$ was the multiple coefficient of determination corrected for degrees of freedom, and a superscript of a indicates that in a two-tailed test the coefficient was statistically significant at the .05 level, and a superscript of b indicates that in a two-tailed test the coefficient was statistically significant at the .01 level.

of total enrollment, or $1,538. Therefore, every additional child enrolled in the day care center during the year would have increased the total current cost by $1,538. In the nonlinear case, however, the marginal cost was different for levels of total enrollment. In order to calculate marginal cost for equations 2 and 3, the average enrollment was used. The calculated values of marginal cost, based on an average enrollment of 41 were $2,291 for Equation 2 and $1,620 for Equation 3.

The average current cost calculated for the observed data was $2,506. Therefore, the annual cost of taking care of a child enrolled in a day care center was $2,506.

Figures 1, 2, and 3 show the estimated total current cost curves and their corresponding estimated average cost curves for the center data. The linear total current cost curve in Figure 1 has an estimated average cost curve that is asymptotic to the horizontal axis. The average cost curve appears to support the hypothesis of the existence of economies of scale. That is, as the scale of operation of the day care center expands, average cost declines. The average cost curve in Figure 2 also appears to support the decreasing average cost hypothesis. In Figure 3, however, the average cost curve is slightly convex to the horizontal axis. It seems to indicate that at a particular scale of enrollment average cost will be at a minimum. The calculated size of enrollment where average cost would be at a minimum is 97. Theoretically, any expansion beyond this point would increase costs per child, and the day care center operation would suffer from diseconomies of scale. It must be pointed out here that the average cost functions were not statistically significant, and, therefore, the calculated size of 97 is not a reliable estimate.

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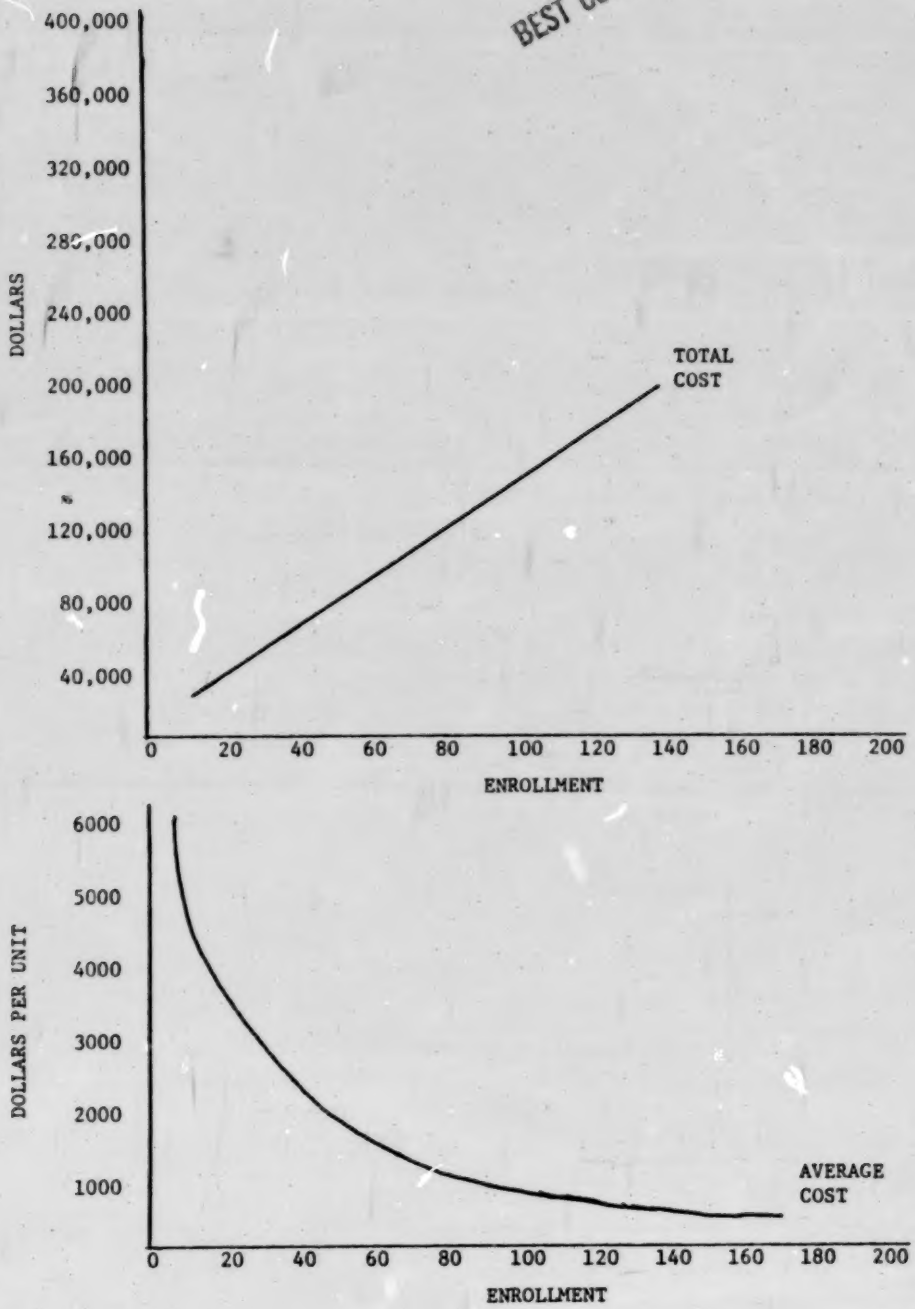

Figure 1. The total cost and average cost curves for the linear total cost equation.

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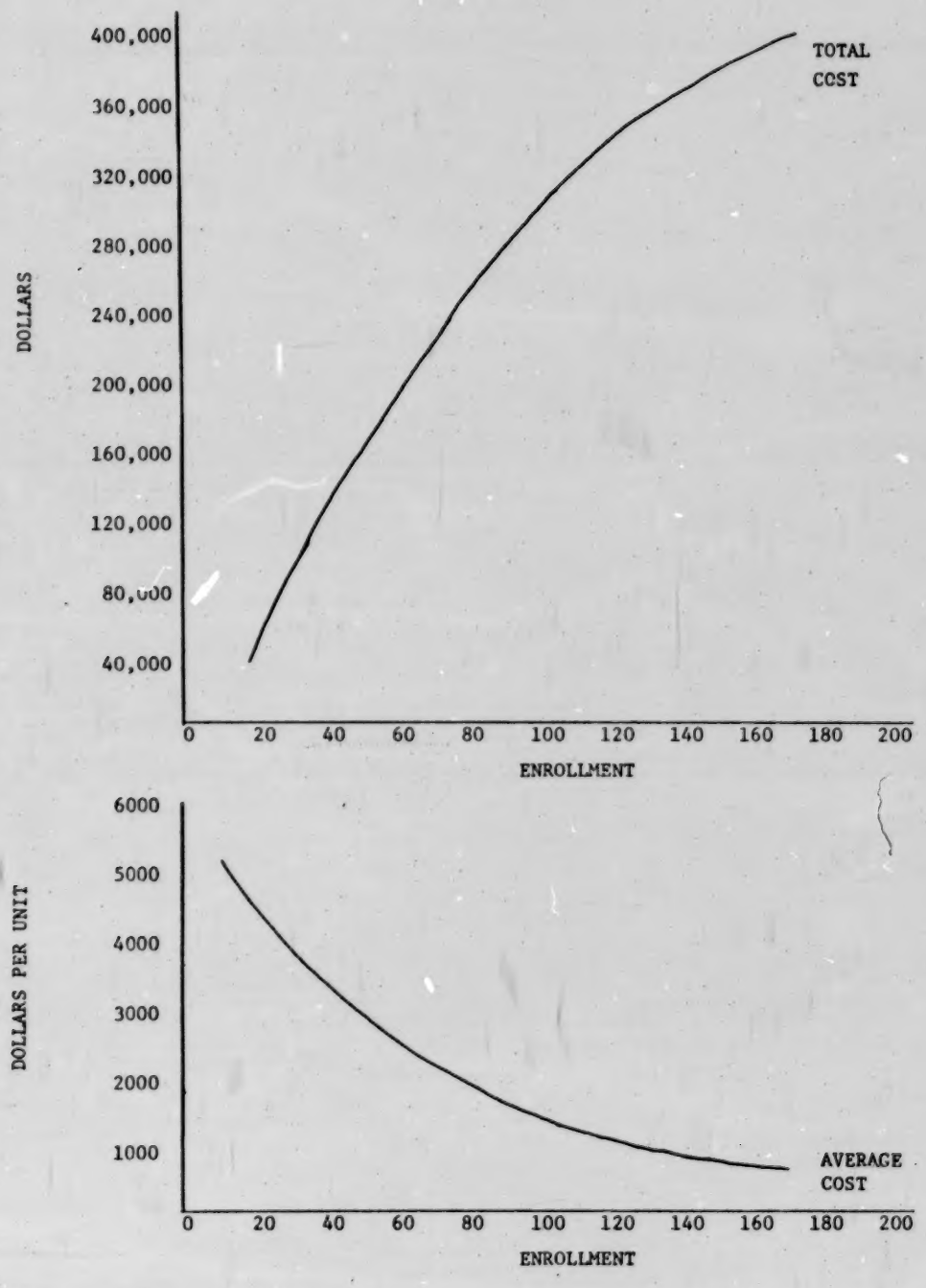

Figure 2. The total cost and average cost curves for the quadratic total cost equation.

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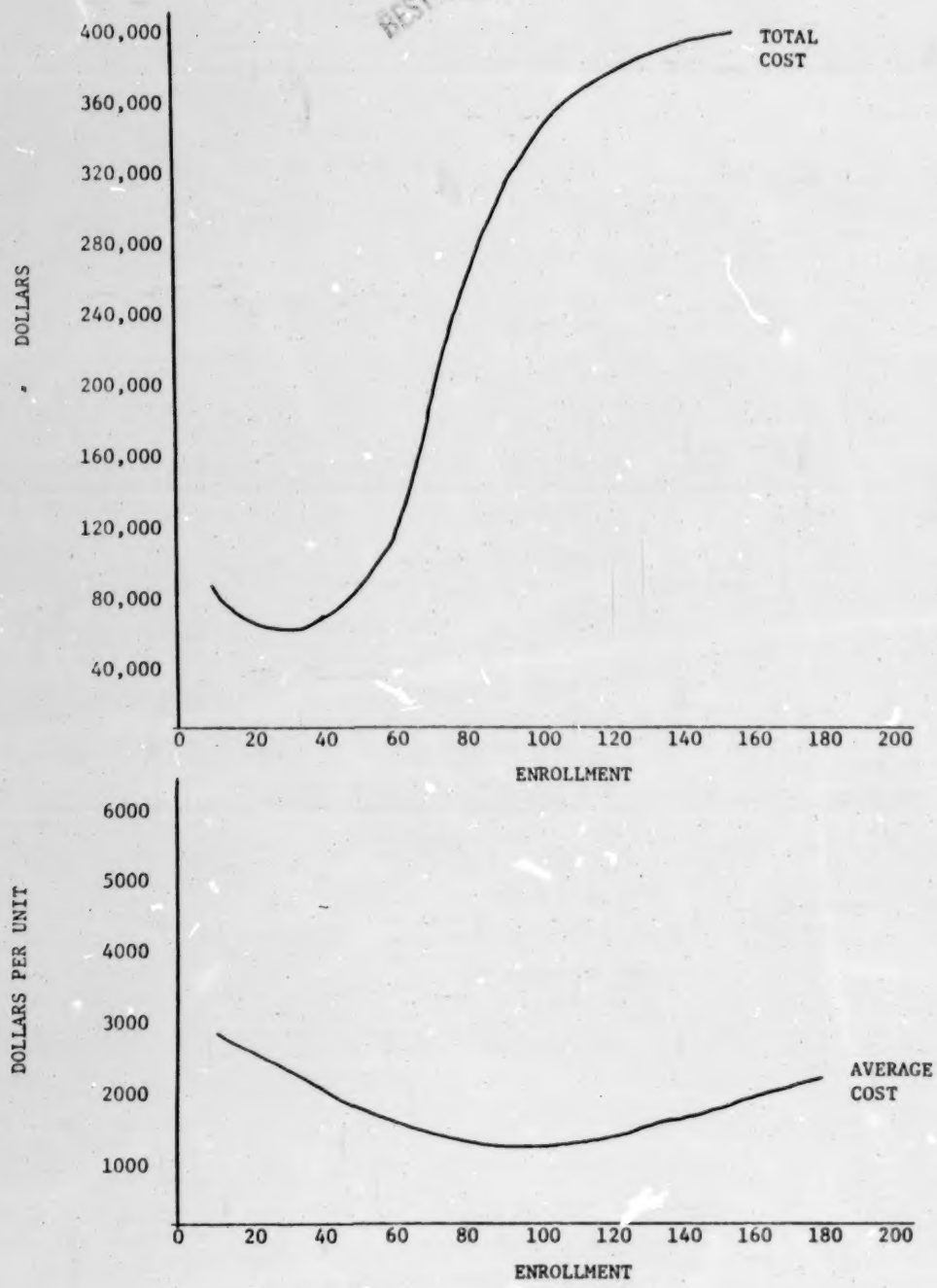

Figure 3. The total cost and average cost curves for the cubic total cost equation.

An alternate method for calculating the optimum size of enrollment in order to obtain the minimum average cost is to take Equation 3 in Table 6 and divide this equation by total enrollment (TE). This procedure will provide an average cost function. When this average cost function is differentiated with respect to TE and the equation is set equal to zero, a solution of 138 is obtained. Thus the average cost will decrease until an enrollment of 138 children is reached.

The logarithmic formulation of total cost also supports the existence of economies of scale. Since the coefficient of the logarithm of enrollment was less than unity, 0.58, a percentage change in enrollment should result in a smaller percentage change in total cost, and the economies of scale principle should be in effect for the range of values of enrollment in this study.

In addition to the study of current costs of day care center operations, an attempt was made to estimate the influence of average teacher salary--as a proxy for the quality of child care--on total current costs. Table 7 presents the estimated regression coefficients for the total and average cost functions. Most of the coefficients in the total cost functions were statistically significant, while those of the average cost functions were not.

When the marginal cost of a 1-unit increase in total enrollment was determined, the inclusion of teacher salary had no significant effect on the marginal cost. The marginal costs of the three total current cost functions are shown in Table 8 in contrast to the marginal costs of the total cost functions with teacher salary included as an independent variable. One can take note of their relatively close magnitudes.

Since the regional data provide total cost information including capital cost, this study has adopted the same cost model for the regional data, and marginal and average costs were obtained from a total cost which included

TABLE 7

TOTAL AND AVERAGE COST FUNCTIONS FOR CENTER DATA WITH ENROLLMENT AND TEACHER SALARY AS INDEPENDENT VARIABLES

Equation	Constant	TE	$(TE)^2$	$(TE)^3$	Log TE	$(TE)^{-1}$	TS	Log TS	$\bar{R}^2$	F
1a (TC)	-112350.96[a] (53725.67)	1488.85[b] (363.23)					26.74[b] (9.03)		0.37	13.80
2a (TC)	-133585.78[b] (55030.33)	3108.32[b] (1174.93)	-8.57 (5.92)				24.01[b] (9.11)		0.38	10.14
3a (TC)	-34560.60 (51308.09)	-4416.56[a] (1993.14)	95.09[b] (24.41)	-0.34[b] (0.01)			25.61[b] (7.62)		0.57	15.61
4a (Log TC)	-0.99 (0.99)				0.58[b] (0.11)			1.32[b] (0.27)	0.58	31.19
5a (AC)	-499.38 (1514.26)					14927.67 (11840.03)	0.47[a] (0.22)		0.06	2.51
6a (AC)	159.36 (1889.02)	-7.00 (11.84)				8766.31 (15837.16)	0.45[a] (0.23)		0.05	1.77
7a (AC)	1348.65 (2634.80)	-37.33 (47.99)	0.13 (0.21)			-1263.96 (22152.90)	0.47[a] (0.23)		0.04	1.41

Notes.--N = 45; standard errors are in parentheses; all figures are in dollars; the F value was used to test the significance of the whole equation; $\bar{R}^2$ was the multiple coefficient of determination corrected for degrees of freedom; a superscript of a indicates that in a two-tailed test the coefficient was statistically significant at the .05 level, and a superscript of b indicates that in a two-tailed test the coefficient was statistically significant at the .01 level.

TABLE 8

MARGINAL COSTS OF ENROLLMENT FOR THE CENTER DATA*

Cost function	Independent variables	
	TE	TE, TS
Table 6 (1)	$1,538	
Table 7 (1a)		$1,489
Table 6 (2)	$2,291	
Table 7 (2a)		$2,408
Table 6 (3)	$1,620	
Table 7 (3a)		$1,666

*Marginal costs are estimated for the average enrollment of day care centers in the study.

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TABLE 9

TOTAL AND AVERAGE COST FUNCTIONS FOR THE REGIONAL DATA WITH ENROLLMENT AS AN INDEPENDENT VARIABLE

Equation	Constant	TE	$(TE)^2$	$(TE)^3$	Log TE	$(TE)^{-1}$	$\bar{R}^2$	F
1 (TC)	12846.98 (39451.37)	2561.09[b] (70.36)					0.98	1324.86
2 (TC)	-10864.49 (62899.10)	2758.17[b] (408.28)	-0.08 (0.16)				0.98	637.39
3 (TC)	125522.67[a] (72082.09)	-895.28 (1333.94)	13.54[b] (4.80)	-0.005[b] (0.002)			0.99	585.31
4 (Log TC)	3.82[b] (0.20)				0.81[b] (0.10)		0.77	69.92
5 (AC)	795.23 (828.73)					139652.86[b] (26532.66)	0.56	27.70
6 (AC)	300.79 (968.39)	1.32 (1.34)				148363.54[b] (27972.24)	0.56	14.32
7 (AC)	-4984.18 (1703.37)	30.79[b] (8.54)	-0.01[b] (0.003)			228492.97[b] (32013.63)	0.72	19.16

Notes.--N = 21; standard errors are in parentheses; all figures are in dollars; the F value was used to test the significance of the whole equation; $\bar{R}^2$ was the multiple coefficient of determination corrected for degrees of freedom; a superscript of a indicates that in a two-tailed test the coefficient was statistically significant at the .05 level; a superscript of b indicates that in a two-tailed test the coefficient was statistically significant at the .01 level.

capital expenditures. Table 9 provides the regression results of the total current costs and average current cost functions from the regional data, and Table 10 shows the total current cost and average current cost functions from the regional data.

If the data in Tables 9 and 10 are compared to the data in Tables 6 and 7, the following interesting and somewhat different findings are revealed:

a. Estimated cost functions based on regional data fit the observed data much better than those equations based on center data.

b. Table 9, Equation 3, shows a marginal cost of $2,166 for the mean value of enrollment in a region (TE = 249). This figure shows that, when capital costs are included in the estimation, marginal cost is about $540 more than the marginal cost estimated ($1,620) from current costs (see Table 8). It should be noted that, although three alternative total cost functions fit quite well in those four tables, the cubic equations, Number 3 in each table, conforms to a typical total cost function, and marginal costs have been estimated from this cubic equation. Furthermore, the corresponding average cost functions in Tables 9 and 10 show a statistically significant U-shape average cost curve. This finding lends further support for adopting this cubic equation as a basis for discussion.

c. When the current costs of the regional data are used to estimate marginal cost, Equation 3 in Table 10, the marginal cost is $1,593, which is very close to the marginal cost, $1,620, determined using the current costs of center data.

d. The logarithmic cost equations indicate that the elasticity of total cost (and total current cost) with respect to enrollment is about 0.80; this result implies that a 10% increase in enrollment will result in an 8% increase in total cost.

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TABLE 10

CURRENT COST AND AVERAGE CURRENT COST FUNCTIONS FOR THE REGIONAL DATA WITH ENROLLMENT AS AN INDEPENDENT VARIABLE

Equation	Constant	TE	$(TE)^2$	$(TE)^3$	Log TE	$(TE)^{-1}$	$\bar{R}^2$	F
1 (TCC)	10971.04 (37829.27)	2308.22[b] (66.00)					0.98	1223.03
2 (TCC)	13230.13 (59404.66)	2509.86[b] (382.46)	-0.08 (0.15)				0.98	588.71
3 (TCC)	124541.36[a] (64583.93)	-1347.55 (1241.73)	14.30[b] (4.48)	-0.01[b] (0.00)			0.99	598.55
4 (Log TCC)	3.80[b] (0.20)				0.80[b] (0.10)		0.76	65.97
5 (AV. CC.)	599.33 (800.49)					131315.49[b] (25072.22)	0.57	27.43
6 (AV. CC.)	104.41 (936.66)	1.28 (1.26)				139989.60[b] (26468.32)	0.57	14.25
7 (AV. CC.)	-5057.03 (1585.84)	29.66[b] (7.83)	-0.01[b] (0.00)			218265.84[b] (29566.55)	0.74	20.48

Notes.--N = 21; standard errors are in parentheses; all figures are in dollars; the F value was used to test the significance of the whole equation; $\bar{R}^2$ was the multiple coefficient of determination corrected for degrees of freedom; a superscript of a indicates that in a two-tailed test the coefficient was statistically significant at the .05 level; a superscript of b indicates that in a two-tailed test the coefficient was statistically significant at the .01 level.

All of the statistical evidence points toward the conclusion that the day care centers in the sample are operating at levels of enrollment that fall within the economies of scale. This conclusion can be further substantiated by comparing the average costs with the marginal costs. Table 11 provides the average and marginal costs of the two data sources. Since the average costs (current and total) are greater than the corresponding estimated marginal costs, the average costs must be decreasing as enrollment increases and the centers must be experiencing economies of scale.

TABLE 11

AVERAGE AND MARGINAL COSTS OF DAY CARE CENTERS

Data sources	Average cost		Marginal cost	
	Average current cost	Average total cost	Based on current cost	Based on total cost
Day care centers	$2,506	Not available	$1,620[a]	Not available
Regional data	$3,283	$3,580	$1,593[c]	$2,166[b]

Notes.--[a]Estimated from Equation 3 in Table 6, at the mean value of the enrollment.

[b]Estimated from Equation 3 in Table 9, at the mean value of the enrollment.

[c]Estimated from Equation 3 in Table 10, at the mean value of the enrollment.

Conclusions, Policy Implications, and Future Research

Conclusions and Policy Implications

Earlier in this report we presented a brief review of four major studies of the costs of day care. It was mentioned that the CB-DCCDC study was probably the most accurate of the four, and the Westinghouse study was probably the least significant due to poor data collection and poor cost accounting. None of the four studies reviewed estimated the marginal cost of taking care of an additional child.

The estimated average costs of those studies and the estimated average and marginal costs of this study are presented in Table 12. Several pertinent conclusions can be drawn, and recommendations made, based on Table 12 and/or the findings of this study.

1. Table 12 shows that the average operating cost per enrolled child in a day care center is within the range of $2,000-$3,000, depending on the location of the sample. We feel that $2,500 is a reasonable figure for the present study since we lack confidence in the accuracy of the day care center data which we collected.

2. There are several possible reasons that could explain the discrepancy of the average operating cost between the day care center data and the regional data of this study. The regional data were collected from day care centers which have contracts with the Department of Public Welfare. Therefore, it could be that these centers inflated their actual costs in order to utilize the full amount of appropriation. Secondly, some of the contracted centers were relatively new, and the set-up costs could have caused a relatively high average for operating costs. However, we would recommend

that government funding agencies provide a careful audit of centers with which they are associated in order to eliminate any possible inflation of actual costs. It might even prove to be possible to reduce the contract cost per child.

3. Regional data of the present study show that the difference between the average total cost and average operating cost is about $300 per child enrolled within a year.

TABLE 12

THE AVERAGE DAY CARE CENTER COSTS

Studies		Estimated average cost	No. of centers in sample	Enrollment or average daily attendance	Estimated marginal costs
(1)	CB-DCCDC	$2,320	NA	Enrollment	NA
(2)	Abt Associates	$2,349	20	Average daily attendance	NA
	("good")	$2,067		Enrollment	NA
(3)	Westat ("developmental")	$1,368	289	Enrollment	NA
(4)	Galambos	$3,100	NA	Enrollment	NA
(5)	This study	$2,506[a]	62	Enrollment	$1,620[a]
		$3,580[b]	164	Enrollment	$2,166[b]
		$3,283[c]	164	Enrollment	$1,593[c]

Notes.--NA indicates information was not available.

[a]Based on current cost collected from day care center data.

[b]Based on total cost collected from regional data.

[c]Based on current cost collected from regional data.

4. The average cost function permits inferences about the optimal scale of operation of a day care center. According to the statistical results of

this study, day care centers in Pennsylvania are operating within the decreasing average cost region. One finding indicates that the optimum enrollment size of a day care center is 138 children. At this size, the average cost of the day care service is at its minimum. Therefore, management should be able to expand day care center operations to include up to 138 children without increasing facilities or per unit costs. This suggestion should be useful for government agencies which fund day care centers. That is, within an area such as a township or a borough, the government should set up a certain minimum size of enrollment for a funded day care center. Only when enrollment exceeds this limit should the government approve an additional day care center in the area.

5. For funding or reimbursement purposes, the government should use the average cost estimate to compensate various centers when compensation is based on the existing sizes of enrollment. However, if the future expansion of a center is in question, the marginal cost estimate should be used. The purpose of estimating marginal cost in this study was to provide decision-makers with the proper tool for making a rational decision when allocating funds to those centers that are expanding their operations. The marginal cost for additional enrollment in a day care center in Pennsylvania is about $1,600 per child when it is based on operating costs, and $2,170 when based on total cost, which includes capital expenditures.

Future Data Collection and Research

In order to come to any further conclusions or to answer any questions raised by this analysis, additional research is certainly required. Along with the need for further research is the great need for data. The lack of proper data is probably the largest limitation of this study. Therefore,

the following suggestions are made for future data collection with respect to the significant and efficient analysis of the costs of day care centers.

1. Data should be collected on the number of staff members, i.e., teachers, directors, etc., since the best measure of the quality of a day care center has been found to be the staff/child ratio.

2. Data should be collected on the average daily attendance of the children in the center. As was pointed out previously, average cost based on average daily attendance is more accurate than average cost based on levels of enrollment.

3. Data should be collected on the capital costs of day care centers. The total cost of day care consists of current costs and capital costs. In order to estimate the average and marginal costs of day care, one should really deal with the total costs, not just the current costs. If capital costs are included in the estimation of the average cost functions, then inferences could not only be made about the short-range expansion of enrollment but also about the long-range expansion of day care center facilities.

4. Data should be collected from the nonrespondent centers of this study. Many centers had to be eliminated from the sample because certain questions were not answered. If the nonrespondents were contacted again for answers to particular questions relating to this cost study, then the usable sample would be larger and the estimated coefficients possibly more significant. One variable not included in the analysis was the location factor as an influence on costs. If the respondent sample were larger, the significance of location could be determined, and inferences could be made in regard to the urban or rural location of the center and the effect of location on costs.

There are many unanswered questions about day care, and there exist many unexplored areas of research, but it might be useful to mention three particular unexplored areas here. First, the cost of alternative forms of day care services could be studied--day care homes, for example. It would be useful for legislatures to be able to compare the differences in the cost and quality of care of alternative day care programs. Second, a comparison of the costs of subsidized day care centers and nonsubsidized day care centers would be helpful in determining whether subsidized centers are less efficient. Finally, it would be useful to estimate the social cost of providing day care centers, that is, not only the cost incurred by the day care center but also the resources and effort provided by the society as a whole, such as the efforts of parents and charity organizations.

Summary

The authors used the least-squares regression technique to determine the cost of, and the optimum enrollment for, day care centers in Pennsylvania. Data were obtained from the Pennsylvania Day Care Study Project and the Pennsylvania Department of Public Welfare. The following were the results:

a. Based on survey information obtained directly from the day care centers, the average operating cost per child enrolled in a day care center in Pennsylvania is about $2,500. However, the cost data obtained from regional centers (contracted with the Department of Public Welfare) showed it to be about $3,300 per enrolled child.

b. Findings based on the regional data indicate that the difference between the average total cost and the average operating cost per child enrolled for a year is about $300.

c. The extra cost of enrolling an additional child in a day care center is about $1,600. This figure is about $900 less than the average operating cost per child.

d. The results of average cost functions indicate that, in general, existing day care centers can expand to an enrollment of 138 children and still achieve a reduction in the average cost per child.

The following major recommendations were made for policy decisions within government funding agencies:

a. Funding agencies should provide a careful financial audit of the operations of day care centers that have contracts with them in order to eliminate such occurrences as the discrepancy of $800 per child between the two data sources of this study. Possibly the agency should reduce the contract cost per child.

b. Funding agencies should set up a certain minimum size of enrollment for contracted day care centers so that the average cost per child can be reduced to a minimum. Only when the enrollment of a center exceeds this limit should this agency or the Department of Education approve an additional day care center in an area.

c. Funding agencies should provide guidelines for a uniform data collection system so that useful and meaningful information can be easily obtained for the purpose of evaluation and better management.

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